International Journal of Neurosurgery
2022; 6(2): 32-37
http://www.sciencepublishinggroup.com/j/ijn
doi: 10.11648/j.ijn.20220602.11
ISSN: 2640-1940 (Print); ISSN: 2640-1959 (Online)

Ambulatory Endoscopic Lumbar Foraminotomy for Spinal Stenosis During COVID-19 Pandemic: A 27-Patient Case Series of Transpedicular Approach Under Sedation

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To cite this article:

Carlos Sajama, Gustavo Zomosa, Gonzalo Suarez, Mario Castillo, Gino La Rosa, Pedro Vergara. Ambulatory Endoscopic Lumbar Foraminotomy for Spinal Stenosis During COVID-19 Pandemic: A 27-Patient Case Series of Transpedicular Approach Under Sedation. *International Journal of Neurosurgery*. Vol. 6, No. 2, 2022, pp. 32-37. doi: 10.11648/j.ijn.20220602.11

Received: June 1, 2022; **Accepted**: June 30, 2022; **Published**: July 20, 2022

Abstract: Background: To demonstrate the safety of the endoscopic lumbar foraminotomy for spinal stenosis and to study clinical outcomes. During the COVID-19 Pandemic there was a lack of beds for elective surgeries that we solved starting to develop ambulatory endoscopic lumbar foraminotomy for foraminostenosis under sedation. Methods: Retrospectively we study 27 patients with foraminostenosis who were operated endoscopically under sedation since October 2020 to October 2021 in our hospital, by a single senior neurosurgeon. Demographics variables and hospital stay times were reviewed. Each patient's functioning was assessed using the Oswestry Disability Index (ODI) and the visual analog scale (VAS) score for leg pain. Postoperatively, patients were evaluated at 1 month and 1 year. Results: In twenty-seven patients we performed endoscopic foraminotomies under sedation. Eleven were females (40,7%). The average hospital stay time was 6 hours, there was a statistically significant reduction of the preop, post op and final VAS and preop, post op and final ODI. Like the PREOVAS data, POSTOVAS and FVAS do not have normal distribution, a non-parametric ANOVA is performed, obtaining KW = 73.26, $p < 0.0001$, then, there are statistically significant differences between these three variables. For the variables PREODI, POSTODI and FODI, since they are not normal, a non-parametric ANOVA is performed, obtaining KW = 59.03, $p < 0.0001$, then, there are statistically significant differences between these three variables. To make comparisons between the VAS and ODI variables, use the Mann Whitney non-parametric method to compare if there is a difference between the medians of the different groups and there is a statistically significant difference between the variables compared with $p < 0.0001$ in all cases. A Cluster analysis was also made and for elderly patients the reduction of ODI was bigger than the young ones. Conclusions: The authors recommended ambulatory endoscopic lumbar foraminotomy for electives patients when there is a lack of beds in hospital for prolonged stays. There were statistically significant reductions of VAS and ODI score preoperative to post operative with a maximum of 8 hours between the admission to the discharge.

Keywords: Spinal Stenosis, Endoscopic Foraminotomy, Minimally Invasive Spine Surgery, Transforaminal Approach

1. Introduction

With the increase in life expectancy of the population, degenerative disease of the spine has also increased [1-4]. Spinal stenosis or lumbar spinal stenosis is a degenerative disorder characterized by a narrowing of the spinal canal, lateral, foraminal or extraforaminal recess that was first described in 1954 by the Dutch neurosurgeon Henk Verbiest [5-7]. Generally spinal stenosis has a multifactorial cause, resulting from the combination of degenerative changes secondary to aging and post-micro-trauma inflammatory processes [6]. The most common cause is spondylosis, which typically affects adults over 60 years of age [8]. Within the most frequent anatomopathological causal are hypertrophies or cysts of the facet or of the ligamentum flavum, disc herniations, osteophyte formation and degenerative spondylolisthesis. They can be isolated causes or combinations of them [6]. Staats et al. in a series of 274 patients, they found that 95% of them had up to 5 spinal comorbidities [9].

There is great interest in development of minimally invasive procedures for spine surgery (MISS) such as percutaneous lumbar decompression or minimally invasive lumbar decompression, being the currently preferred surgical technique [6, 10, 11]. One of the pioneers was the team of Kambin et al, more than 30 years ago [12]. Technical and imaging advances have allowed its greater diffusion and application [13], evolving with the use of endoscopes of different sizes and the use of high-speed motors to shorten surgical time [2, 10, 11].

2. Methods

Our study included 27 patients who underwent endoscopic foraminotomy in our center between October 2020 and October 2021, previously approved by hospital review board. Preoperatively, each patient's functioning was assessed using the Oswestry Disability Index (ODI) [14, 15] and the visual analog scale (VAS) score for leg pain [16]. Postoperatively, patients were evaluated at 1 month and 1 year. This retrospective study was made in a single center. All patients provided informed consent for the procedure and graphics images obtained. All surgeries were carried out by a single senior neurosurgeon.

The inclusion criteria for this study were: 1. Foraminostenosis uni or bilateral; 2. Symptomatic lumbar radiculopathy, dysesthesias, or decreased motor function; 3. Neurogenic claudication; 4. Failure to medical and kinesiological treatment.

The exclusion criteria were: 1. Metastatic disease; 2. Infection.

For all the patients we solicited MRI and (CT) scans when extensive facet arthropathy or other obstacles to the foraminal access were suspected.

3. Surgical Procedure. Patient Positioning and Anesthesia

For the endoscopic foraminotomy, the patient is positioned prone on a soft Wilson frame. The anesthesia staff uses a continuous infusion of dexmedetomidine (Precedex) and propofol for conscious sedation and allows the surgeon to communicate with the patient when needed verbally, this part of the procedure Its critical to confirm that there is no damage of the roods and allowed early discharge [17-21].

The surgeon injects local anesthetic, using 2% lidocaine for skin anesthesia and 1% lidocaine into the muscular working tract. Local anesthesia employed in such way decreases the painful stimulus during the procedure and simplifies the medical anesthesia, with a level 3 on the Ramsay scale, which has been reported to achieve better anxiolysis and intra- and postoperative analgesia [22]. (video 1)

4. Transforaminal Surgery

The incision is made 8 to 12 cm from the midline while allowing parallel access to the surgical disc inter- space. The neuroforamen is target with a 18G needle (150mm length) into safe zone of Kambin's triangle [23, 24] A 7-mm working cannula is placed into the surgical neuroforamen after serial dilation. We use a 20° high-definition foraminoscope. The working cannula has a 45° bevel allowing use as a nerve root retractor and exposing a much larger surgical area than dictated by its diameter. (Figure 1)

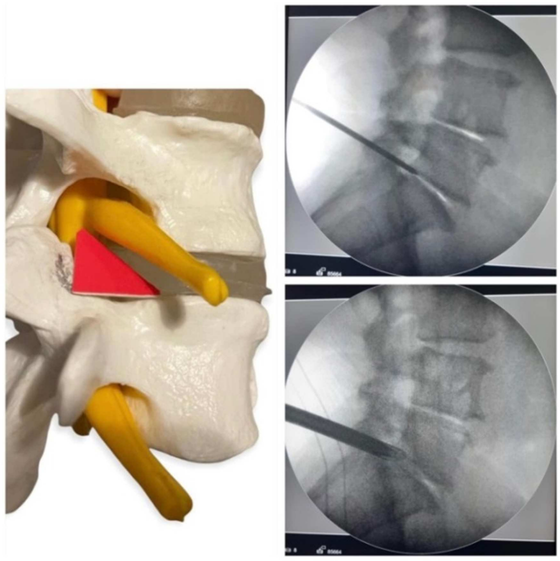


Figure 1. *Kambin´s triangle, trocar and cannula.*

All surgeries were performed by the author with his modified form of the outside-in technique originally popularized by Hoogland et al [25-27] An initial foraminoplasty is made to achieve proper decompression and release of both exiting and traversing nerve roots, so in that way its allowed to decrease compressive symptoms.

The decompression begins on the facet joint toward the pars interarticularis, releasing the exiting nerve root, and concluding on the caudal pedicle, releasing the traversing nerve root. The endoscopic decompression allows a wide foraminoplasty and dramatically improves access to the now-exposed intervertebral disk. The endoscope and interbody fusion instruments are freely movable in both the axial and the sagittal plane. Nerve roots must be always visualized [28].

5. Results

5.1. Statistical Analysis

In twenty-seven patients we performed endoscopic foraminotomies under sedation. 11 females (40,7%). The mean follow-up was 15 months, ranging from 12 to 18 months. No one was re hospitalized or has complication.

The Shapiro-Wilk test [29] was applied to determine the normality of the variables under study, obtaining for PREOVAS, SW-W= 0.8762 p=0.004; POSTOVAS, SW-W= 0.9312 p=0.074; FVAS, SW-W= 0.761 p=0.00003, only for POSTOVAS an approximation to the normal can be accepted, then a non-parametric method must be used to compare them. For PREODI, SW-W= 0.8257 p=0.0004; POSTODI, SW-W= 0.8807 p=0.0050; FODI, SW-W= 0.7358 p=0.00001, no variable has a normal distribution, so a non-parametric method must be used to compare them.

Like the PREVAS data, POSTVAS and FVAS do not have normal distribution, a non-parametric Kruskal-Wallis ANOVA (30) is performed, obtaining: KW=73.26, p < 0.0001, then, there are statistically significant differences between these three variables.

For the variables PREODI, POSTODI and FODI, since they are not normal, a non-parametric Kruskal-Wallis ANOVA [30] is performed, obtaining KW=59.03, p < 0.0001, then, there are statistically significant differences between these three variables.

To make comparisons between the VAS and ODI variables, use the Mann Whitney non-parametric method [31] to compare if there is a difference between the medians of the different groups, obtaining: PREOVAS vs POSTOVAS, SR=1106.379, Mann-Whitney U=1, p < 0.0001; PREOVAS vs FVAS, SR=1107.378, Mann-Whitney U=0, p < 0.0001; PREODI vs POSTODI, SR=1092.393, Mann-Whitney U=15, p < 0.0001; PREODI vs FODI, SR=1105.38, Mann-Whitney U=2, p < 0.0001; there are a statistically significant difference between the variables compared with p < 0.0001 in all cases.

Figure 2 shows the minimum, maximum and average values of each of the variables under study, using Prism 9 software, values that are detailed in Table 1.

Table 1. *Descriptive summary of the variables.*

Variable	PREOVAS	POSTOVAS	FVAS	PREODI	POSTODI	FODI
Minimum	6	1	1	26	2	0
Maximum	9	6	5	68	58	36
Range	3	5	4	42	56	36
Mean	7,778	3,185	1,852	56,44	20,19	9,111
Std. Deviation	0,892	1,241	1,099	8,794	11,08	7,490
Std. Error of Mean	0,172	0,239	0,212	1,692	2,132	1,441

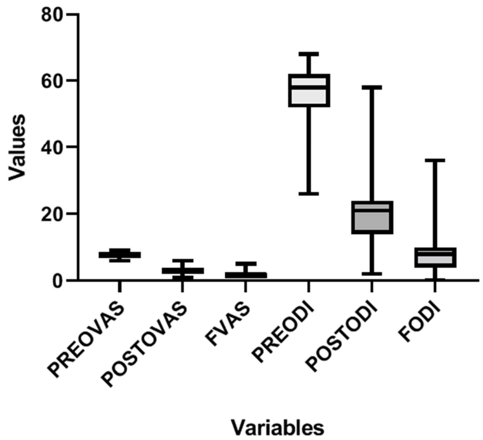


Figure 2. *Box plot.*

5.2. Cluster Analysis

From the standardized data matrix, the corresponding correlation matrix is obtained, to which the Cluster Analysis method is applied [32-34], using Statistica 10.0 software. Figure 3 shows the cluster analysis of the patients, with respect to the variables under study, obtained from the corresponding correlation matrix.

Patients P19M, P20F, P22M and P21F are in the grouping on the extreme left. Their behavior with respect to the variables under study can be seen in Figure 3. In the grouping on the right are patients P1M, P4M, P16F. The average age of the patients in the grouping on the left is greater than that of the patients on the far right. The patients on the extreme right present average values of PREVAS, POSTVAS and FVAS higher than the patients on the extreme left. Figure 4.

The PREVAS and PREODI variables do not have a normal distribution, therefore the Spermman correlation coefficient [35] is calculated, obtaining r=0.1601 with p=0.3814 > 0.05, so there is no correlation between these variables.

The FODI and FVAS variables do not have a normal distribution, therefore the Spearman correlation coefficient is calculated, obtaining r=0.4382 with p=0.0121 < 0.05, then the variables are correlated.

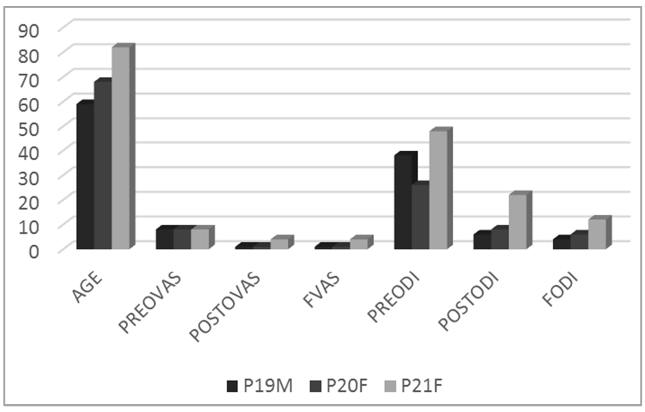


Figure 3. *Bar chart.*

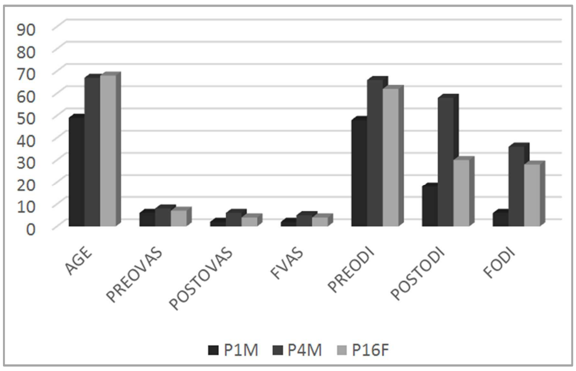
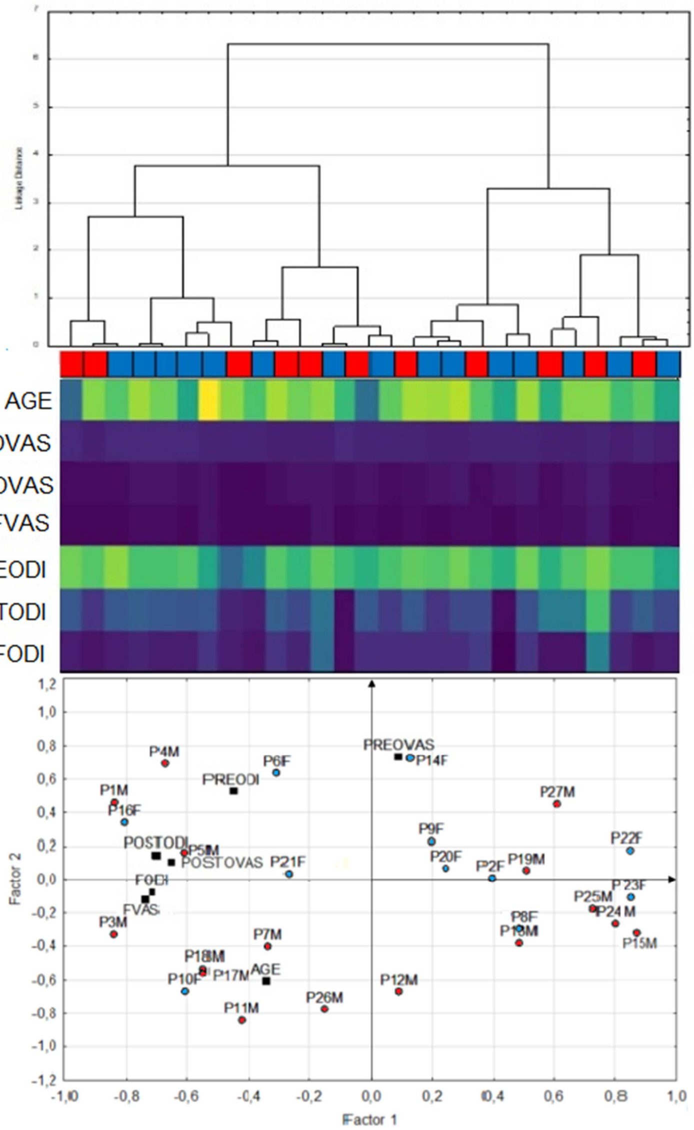


Figure 4. *Bar chart.*

5.3. Principal Component Analysis (PCA)

From the correlation matrix of the data under study, a principal component analysis is performed [32, 33, 34], Figure 5. The PCA analysis determines the behavior pattern of the variables and patients, which are projected to a two-dimensional plane, using Statistica 10.0 software.

In Figure 5, the patients who are in the first quadrant are highly correlated with the PREVAS variable, to a lesser extent with the PREODI, POSTODI and POSTVAS variables, and very little correlation with the FODI, FVAS and AGE. Quadrant 2 patients are highly correlated with the variables PREODI, POSTODI and POSTVAS, to a lesser extent with PREVAS, FODI, FVAS and AGE. Quadrant 3 patients are highly correlated with the FODI, FVAS and AGE variables, to a lesser extent with the FODI, FVAS and AGE variables, and almost none with the PREVAS variable. Quadrant 4 patients have a correlation with the variables PREVAS, FODI, FVAS and AGE, but almost none with the variables PREODI, POSTODI and POSTVAS. The elderly patient who has more disability (height PREODI) are the ones with better FODI outcomes (decrease of disability).



Male patients (red dots) and Female patients (blue dots), variables measured (black squares)

Figure 5. *Cluster, Heat map, PCA analysis.*

6. Conclusions

Based on our initial experience, the authors recommended the ambulatory endoscopic lumbar foraminotomy for spinal stenosis specially in times of lack of beds produced by COVID-19. There was statistically significant reduction on preoperative to post operative VAS and ODI scores performed by a transforaminal approach under sedation with a minimum hospital stay maximum of 8 hours a critical safety solution reducing the final cost of the hospitalization with no complication.

Abbreviations

VAS: Visual analog scale, ODI: Oswestry disability index, PREOVAS: Preoperative VAS, POSTOVAS: Post operative VAS, FVAS: Final VAS, PREODI: Preoperative ODI, POSTODI: Post operative ODI, FODI: Final ODI, PCA: Principal Component Analysis, SW: Shapiro-Wilk test, KW: Kruskal-Wallis ANOVA.

Disclosures

All the authors denied any support or interest conflicts.

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